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AP●LLO

GUIDANCE, NAVIGATION AND CONTROL

MIT CHARLES STARK DRAPER LABORATORY

CAMBRIDGE MASSACHUSETTS 02139

AP☾LLO

GUIDANCE, NAVIGATION AND CONTROL

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R-567

GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED LM EARTH ORBITAL AND
LUNAR MISSIONS USING
PROGRAM LUMINARY 1E

SECTION 7 ERASABLE MEMORY PROGRAMS

April 1972

MIT CHARLES STARK DRAPER LABORATORY

CAMBRIDGE, MASSACHUSETTS, 02139

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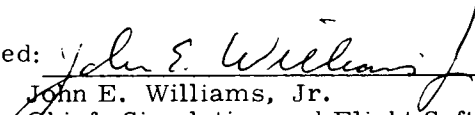
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USING PROGRAM LUMINARY 1E

SECTION 7 ERASABLE MEMORY PROGRAMS

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* These EMPs will be supplied at a later date as change pages.

Note: The Erasable Memory Programs (EMP) contained in this section are individually paginated within each EMP.

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INTRODUCTION

GENERAL

Section 7 of the Guidance System Operations Plan (GSOP) describes erasable-memory programs (EMPs) designed for the guidance computers used in the command (CMC) and lunar modules (LGC). CMC programs are designated COLOSSUS 3, and the associated EMPs are identified by a three-digit number beginning with "5." LGC programs are designated LUMINARY 1E, and the associated EMPs are identified, with one exception, by a three-digit number beginning with "1." The exception is EMP 99.

The EMPs vary in complexity from a simple flagbit setting to a long and intricate logical structure. They all, however, cause the computer to behave in a way not intended in the original design of the programs; they accomplish this off-nominal behavior by some alteration of erasable memory to interface with existing fixed-memory programs to effect a desired result.

> CAUTION.—Great care must be taken when loading or performing an EMP. An erroneous digit loaded into NOUN 26, for example, could cause indeterminate operation upon program initiation.
>
> NOTE 1.—The EMPs described in this section should not be run simultaneously except when explicitly specified.
>
> NOTE 2.—Level 6 performance-evaluation testing has not been performed on EMPs.

The following format is used throughout this section:

NUMBER AND NAME OF EMP.

PURPOSE.

FUNCTIONAL DESCRIPTION—a brief description of the EMP and how it interfaces with fixed-memory programs (may include a functional-flow diagram).

ASSUMPTIONS—prerequisite conditions and configurations.

RESTRICTIONS AND LIMITATIONS—conditions and operations that would interfere with, or be affected by, the EMP.

PROCEDURES—instructions for performing the EMP.

RECOVERY/TERMINATION—procedures for terminating the EMP or recovering from a hardware or software restart.

ERASABLE MEMORY—listing of memory locations (octal) and the code (mnemonic and octal) comprised by the EMP.

UPLINK—P27 format for loading the EMP into erasable memory.

JOBS AND TASKS

A number of EMPs are initiated by VERB 30 ENTR (Request Executive) or VERB 31 ENTR (Request WAITLIST). When the EMP is programed as a JOB, the activation procedures specify VERB 30 ENTR; when the EMP is programed as a TASK, the procedures specify VERB 31 ENTR. The distinction is on the basis of how the program is dispatched. A JOB carries a priority; when the JOB's priority comes up on the executive queue, the JOB is activated. A TASK differs in that it is performed as a T3-clock interrupt. The AGC WAITLIST program sets the T3 clock to overflow at a specified time; when the overflow occurs, other program activity is interrupted, and the TASK is performed.

For VERB 30 use, the JOB's priority is specified in R1 of NOUN 26. R1 of NOUN 26 also contains in the low-order digit an indication of whether or not the JOB is to be assigned a VAC area: if the low-order digit is "1," a VAC area is reserved for the JOB; if it is "0," no VAC area is reserved.

For VERB 31 use, R1 of NOUN 26 must contain the time specified to elapse (in centiseconds) between the keying of ENTR (after VERB 31) and TASK execution.

EMPs activated by VERB 30 ENTR (i.e., JOB EMPs) require NOUN 26 to be loaded as follows:

$$R1 = xx00y_8$$

where

xx_8 = JOB Priority

y = 1 designates a VAC JOB;

y = 0 designates a NOVAC JOB.

$$R2 = xxxxx_8$$

where

$xxxxx_8$ is the JOB starting address

$$R3 = xxxxx_8$$

where

$xxxxx_8$ is the BBCON, containing the fixed, super, and erasable banks associated with the JOB

EMPs activated by VERB 31 ENTR (i.e., TASK EMPs) require NOUN 26 to be loaded as for a JOB EMP, except that R1 contain not a JOB priority, but a time delay as described above:

$$R1 = xxxxx_8 \quad \text{cs delay}$$
$$R2 = xxxxx_8 \quad \text{starting address}$$
$$R3 = xxxxx_8 \quad \text{BBCON}$$

The BBCON is packed as follows:

Bit   15 14 13   12 11 ,10   9 8   7   6 5 , 4   3 2 1

         Octal F-bank   Octal S-bank   Octal E-bank

F-banks $00-27_8$ are addressed independently of S-bank contents; F-banks $30-37_8$ are addressed for S-bank values of 3_8 or less, and F-banks $40-43_8$ are addressed for an S-bank value of 4_8:

Example 1

$$BBCON = 66107_8$$

F-bank 33 ⎤
S-bank 4 ⎦ F-bank 43_8
E-bank 7

Example 2

$$BBCON = 66063_8$$

F-bank 33 ⎤
S-bank 3 ⎦ F-bank 33_8
E-bank 3

<u>Example 3</u>

$$BBCON = 02006_8$$

F-bank 01

S-bank unnecessary

E-bank 6

DOWNLINK

Listed below are the EMPs and the particular downlist transmitted during the operation of each EMP:

COLOSSUS

<u>EMP</u>		<u>Downlist</u>
500		P22 List
501		P22 List
502		Any
503		Coast and Align List
504		Rendezvous and Prethrust List
505	P20/P23	Rendezvous and Prethrust List
	P22/P24	P22 List
	P5X	Coast and Align List
506		Rendezvous and Prethrust List
508		P22 List
509		Any
512		Powered List, Coast and Align List
513		Entry and Update List
514		Rendezvous and Prethrust List
515		Rendezvous and Prethrust List
517		Coast and Align List
518		Coast and Align List, Entry and Update List (during P27)
520		Rendezvous and Prethrust List, Coast and Align List
521		Coast and Align List
522		Any but Powered
523		Any but Powered

LUMINARY

EMP	Downlist
99	Orbital Maneuvers List
100A & 100B	Any
101	Orbital Maneuvers List
102	Any
103A & 103B	Descent and Ascent List
104	Rendezvous and Prethrust List
106	Coast and Align List, Lunar Surface Align List
107	Descent and Ascent List
108	Any

EMP 99: GUIDED RCS TRANSLATIONAL MANEUVER

PURPOSE:

Erasable Memory Program EMP 99 provides an unmanned RCS translational thrusting capability. This capability applies to earth and to lunar orbits.

FUNCTIONAL
DESCRIPTION:

When P99 is initiated (VERB 30 ENTR), the powered flight downlist is selected. (See Figure: EMP 99.) The initial thrust direction and the initial value of the VG vector is calculated by the powered-flight and navigation routines. The attitude errors are zeroed, the DAP deadband is set to 1 deg, and the attitude maneuver is requested. When the attitude maneuver has completed, the master ignition routine interrogates a register tabulation for calling the appropriate program. P99 values for this table are uplinked as part of the P99 code. The master ignition routine then branches upon these points to appropriate routines in the powered flight program, which display values of interest including time from ignition before the engine-on signal is given and time from engine cutoff. The powered-flight program displays $\Delta \underline{v}$ residuals for monitor purposes. The P99 burn program is finished when P00 is selected as a response to the $\Delta \underline{v}$ residuals. P99 is a lead-in to the powered-flight program with the appropriate registers uplinked with the P99 code.

ASSUMPTIONS:

Program coding has been uplinked via P27 (see ERASABLE MEMORY and UPLINK).

RESTRICTIONS
AND LIMITATIONS:

The use of EMP 99 is restricted as follows:

1. See RECOVERY
2. Use with descent stage prohibited unless the following are effected:

    a. Content of Erasable Memory location 3405 is changed from octal 12324 to octal 12327 (TCF WANTAPS becomes TCF ULLGNOT)
    b. NOUN 46 in R03 must be loaded to indicate descent stage, i.e., R1 Digit A = 2

3. If two-jet ullage is to be used, the following locations must be changed:

ECADR	Tag		Code		Octal (New)	Octal (Old)
3734	F	2DEC	0.08896 B-7		00013	00026
3735					14303	30605

This changes the value of thrust from 400 to 200 lb.

Also, the NOUN 46 load in R03 must indicate two-jet ullage, i.e., R1 digit B set to 0 or 1.

PROCEDURES: 1. Perform preliminary procedures before LM jettison (Crew):

a. DAP Data Load Routine (R03)

b. External Δv Targeting Program (P30)

c. GUID CONT set to PGNS

d. MODE CONTROL (PGNS) set to AUTO

e. ENG ARM set to OFF

f. UP DATA LINK set to DATA (to accept uplinked instructions)

2. Set up EMP 99 as follows (Ground):

a. Key VERB 96 ENTR to set QUITFLAG (to interrupt P00 state-vector integration)

b. Key VERB 5 NOUN 26 ENTR and verify address for EMP 99:

R1 13001
R2 01420
R3 12067

3. Execute EMP 99 as follows:

a. Key VERB 30 ENTR to initiate EMP 99, which selects powered-flight downlist

b. Observe 99 in PROG registers

c.   Observe display of desired burn attitude:

<u>FL VERB 50 NOUN 18</u>

R1	xxx.xx deg	R
R2	xxx.xx deg	P
R3	xxx.xx deg	Y

<u>NOTE.</u>—DAP deadband is set to 1 deg for maneuver and burn; reference attitude is set to present attitude.

d.   Key VERB 33 ENTR to execute attitude maneuver to burn attitude

e.   When maneuver has completed, observe return of desired burn attitude display:

<u>FL VERB 50 NOUN 18</u>

R1	xxx.xx deg	R
R2	xxx.xx deg	P
R3	xxx.xx deg	Y

f.   Key ENTR

g.   Observe display of time from ignition:

<u>VERB 06 NOUN 40</u>

R1	xxBxx min,sec	TFI
R2	xxxx.x ft/sec	VG
R3	xxxx.x ft/sec	Δv

<u>NOTE.</u>—DSKY blanks at TIG-35. AVERAGEG Routine starts at TIG-30, and DSKY display is re-established.

h.   Observe TIG:

<u>VERB 06 NOUN 40</u>

R1	00B00 min,sec	TFI
R2	xxxx.x ft/sec	VG
R3	xxxx.x ft/sec	Δv

99-3

NOTE.—P42 guidance equations and DAP offset acceleration estimator enabled.

i.   Monitor NOUN 40 countdown to engine cutoff.

NOTE.—NOUN 40 (R1) now contains time from engine cutoff (TFC).

j.   At cutoff, observe flashing display of cutoff parameters:

<u>FL VERB 16 NOUN 40</u>

R1	00B00 min,sec	TFC
R2	xxxx.x ft/sec	VG
R3	xxxx.x ft/sec	Δv

NOTE.—DAP offset acceleration estimator disabled, and DAP deadband is returned to pre-EMP 99 value.

k.   Key VERB 33 ENTR and observe display of burn residuals:

<u>FL VERB 16 NOUN 85</u>

R1	xxxx.x ft/sec	VGX
R2	xxxx.x ft/sec	VGY
R3	xxxx.x ft/sec	VGZ

NOTE.—DAP deadband is set to 0.3 deg; reference attitude is set to present attitude.

l.   Key VERB 33 ENTR and observe display, "Please select new program":

<u>FL VERB 37</u>

NOTE.—DAP deadband is returned to pre-EMP 99 value.

m.   Key 00 ENTR and observe 00 in PROG registers

NOTE.—AVERAGEG Routine turns off, and Coast/Align Downlist is selected.

RECOVERY/
TERMINATION:

1. Before attempting another burn, ensure that ENG ARM and ENG GMBL switches have been restored to appropriate positions.

2. Once EMP 99 has been loaded, new landing-radar padloads must be uplinked before attempting a lunar landing.

3. Once EMP 99 has been loaded, new ATIGINC/PTIGINC padloads must be uplinked before attempting transfer-phase midcourse targeting (P35/P75).

4. Once EMP 99 has been loaded, new AOTAZ and AOTEL padloads must be uplinked before attempting an IMU alignment.

5. To terminate EMP 99 at any time, key VERB 96 ENTR. The DAP deadband is returned to pre-EMP 99 value.

ECADR	Tag	Code		Octal
3400	SETDAPFL	TC	DOWNFLAG	05520
3401		ADRES	DRIFTDFL	00312
3402		TC	TASKOVER	05263
3404	P99WHICH	VN	0640	01450
3405		TCF	WANTAPS	12324
3406	P99IGN	TC	DOWNFLAG	05520
3407		ADRES	IDLEFLAG	00161
3410		TC	SETDAPFL	01400
3411		TCF	P40SPOT	12150
3412		DEC	2990	05656
3413		ADRES	STEERING	03667
3414		BBCON	STEERING	74066
3415		TCF	COMMON	12404
3416		TCF	IGNITION	12433
3417		TC	P99IGN	01406
3420	P99	TC	NEWMODEX	05313
3421		DEC	99	00143
3422		CAF	THREE	36266
3423		TS	DNLSTCOD	54333
3424		TC	INTPRET	06060
3425		RTB		77634
3426			E/CALL	10636
3427		CADR	S40.1	56246
3430		GOTO		77650
3431			P40IN+3	75202
3734	F	2 DEC	0.17792 B-7	00026
3735				30605
3736	MDOT	2 DEC	0.05135 B-3	00151
3737				05214
3740	TDECAY	2 DEC	0	00000
3741				00000
3742	VEX	2 DEC	27 B-6	15400
3743				00000
3455	WHICH	ADRES	P99WHICH	01404
1250	DVTHRUSH	OCT	0	00000
3515	DVCNTR	DEC	4	00004
2371	N26/PRI	OCT	13001	13001
2372	N26/2CAD	ADRES	P99	01420
2373		BBCON	P99	12067

UPLINK: P27 uplink for loading LGC erasable memory for EMP 99
is as follows:

Load 1	Load 2	Load 3	Load 4
V71E	V71E	V72E	V72E
24E	12E	17E	15E
3404E	3734E	3400E	3455E
1450E	26E	5520E	1404E
12324E	30605E	3401E	1250E
5520E	151E	312E	E
161E	5214E	3402E	3515E
1400E	E	5263E	4E
12150E	E	3426E	2371E
5656E	15400E	10636E	13001E
3667E	E	3427E	2372E
74066E	V33E	56246E	1420E
12404E		3430E	2373E
12433E		77650E	12067E
1406E		3431E	V33E
5313E		75202E	
143E		V33E	
36266E			
54333E			
6060E			
77634E			
V33E			

```
                    ╭─────────────╮
                    │     P99     │
                    ╰─────────────╯
                           │
                           ▼
                      ╱─────────╲
                     ╱  Display  ╲
                    │     99      │
                     ╲ in PROG  ╱
                      ╲───────╱
                           │
                           ▼
                   ┌───────────────┐
                   │    Select     │
                   │ Powered Flight│
                   │   Downlist    │
                   └───────────────┘
                           │
                           ▼
         ┌───────────────────────────────┐
         │ Determine:                    │
         │ a) Initial Thrust Direction   │
         │ b) Initial V̲G                 │
         └───────────────────────────────┘
                           │
                           ▼
                   ┌───────────────┐
                   │ Zero Attitude │
                   │  Errors; Set  │
                   │Deadband = 1 deg│
                   └───────────────┘
                           │
                           ▼
                      ⬡─────────⬡
                     │    R60    │
                     │ Attitude  │
                     │ Maneuver  │
                     │  Routine  │
                      ⬡─────────⬡
                           │                    Note:
                           ▼               ┌──────────────┐
                      ⬡─────────⬡          │ Decisions Are│
                     │ BURNBABY  │          │   Based on   │
                     │  Master   │─ ─ ─ ─ ─▶│ "Which" Table│
                     │ Ignition  │          │ Register for │
                     │ Routine   │          │Branch Routines│
                      ⬡─────────⬡          └──────────────┘
                           │
                           ▼
                   ┌───────────────┐
                   │   End Burn    │
                   │      at       │
                   │  RCS Cutoff   │
                   └───────────────┘
                           │
                           ▼
                      ╱─────────╲
                     ╱  Display  ╲
                    │   V16 N85   │
                    │     as      │
                     ╲V̲G Residuals╱
                      ╲─────────╱
                           │
                           ▼
                      ╭─────────╮          ┌──────────────┐
                      │  Exit   │─ ─ ─ ─ ─▶│   Exit P99   │
                      ╰─────────╯          │              │
                                           │  and Go to   │
                                           │     P00      │
                                           └──────────────┘
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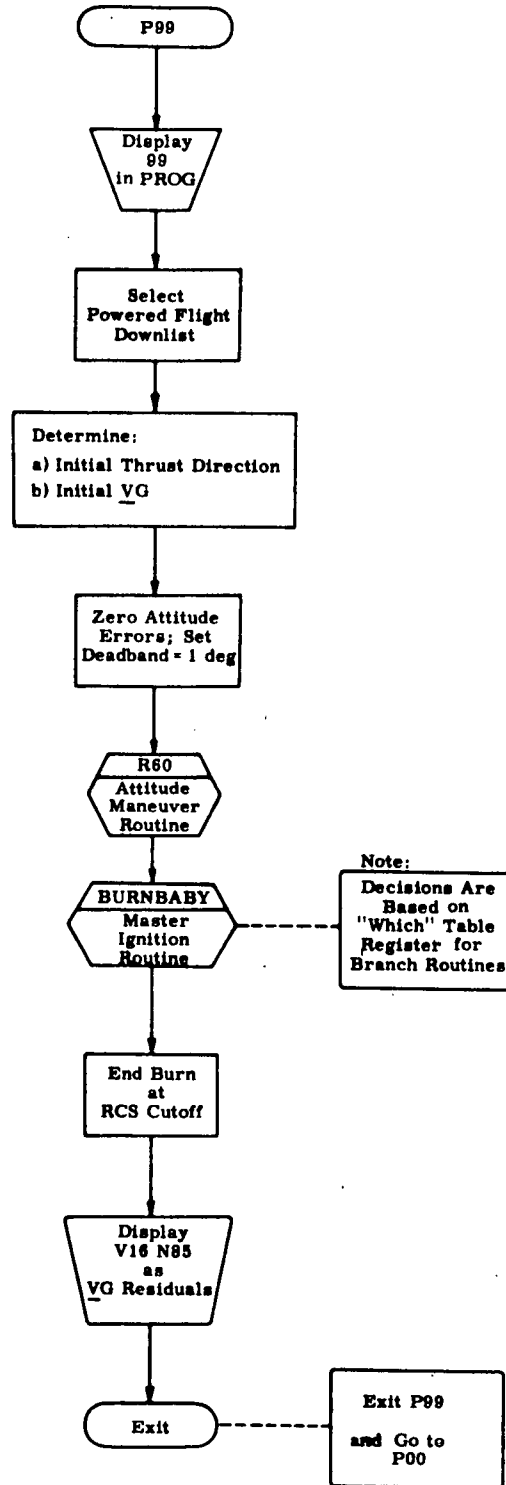
Figure: EMP99

EMP 100A: BACKUP FOR FAILED DSKY KEY
USING ENG GMBL SWITCH

PURPOSE:

Erasable Memory Program EMP 100A provides a means of using the ENG GMBL switch to back up a failed DSKY key.

FUNCTIONAL
DESCRIPTION:

EMP 100A is activated by VERB 31 ENTR. Once activated, sampling occurs once every 20 ms to determine whether the ENG GMBL switch has been moved from ON to OFF. (See Figure: EMP 100A.) If the ENG GMBL switch is detected first ON and then OFF, a single executive call is made to the CHARIN routine of PINBALL. In this call, EMP 100A supplies the preset keycode identifier that corresponds to the DSKY button that has failed. The effect is as though the DSKY button itself were functional and had been depressed. In fact, there is a small time lag between the instant that the ENG GMBL switch is placed in the OFF position and the receipt of the keycode by the PINBALL program, but the lag is far too small to be sensed by the crew.

ASSUMPTIONS:

EMP 100A can be used for DSKY backup when—

1.   A DSKY key (other than PRO/STBY) has failed "open"; i.e., depressing key does not trigger an LGC KEYRUPT

2.   The program has been previously padloaded or uplinked

NOTE.—VAC Area 5 should be checked prior to activation of EMP 100A in order to ensure that the code has not been altered.

3.   High bit rate has been selected

RESTRICTIONS
AND LIMITATIONS:

1.   EMP 100A should not be activated while an erasable-memory dump (VERB 74) is in progress

2.   EMP 100A can be used to back up only one key at a time

3.   There is an increase in probability of a 31201 BAILOUT rstart during periods of high CPU activity. (VAC Area 5 is not available when EMP 100A is active.) This restart has no impact, however, on EMP 100A.

4. There is a small increase (1.46 percent) in CPU time.

5. If ENG GMBL switch is left in OFF position during DPS powered flight, DAP control will be impaired.

6. EMP 100A is deactivated by

    a) VERB 36 ENTR (Fresh Start);

    b) VERB 74 ENTR (Erasable-memory dump).

7. EMP 100A will be deactivated by a hardware restart occurring

    a) during a small interval (<20 ms) following VERB 37 ENTR xx ENTR, entry to P70 and P71, or POODOOs;

    b) during antenna repositioning in P64;

    c) between TIG -30 and turn on of ullage during a powered-flight program.

PROCEDURES: When the prerequisite conditions exist (above), operate EMP 100A as follows:

A. DSKY/UPLINK

1. To change or load key code (KK),
   key—
   > VERB 21 NOUN 1 ENTR
   > 730 ENTR
   > KK ENTR

2. To activate,
   a) key—
   > VERB 5 NOUN 26 ENTR

   b) observe—
   > R1 00001
   > R2 00722
   > R3 10100

   c) key—
   > VERB 31 ENTR

B. ENG GMBL SWITCH

1. Normal—
   To effect keystroke, place ENG GMBL switch to OFF momentarily; then return switch to ENABLE.

NOTE. —Sample rate is 50 times per second; therefore, ENG GMBL switch can be cycled as rapidly as necessary to effect data input. If switch is left in OFF position during DPS operation, however, DAP control of the engine gimbal will be interrupted.

2. Operation with Engine Gimbal Failure (ENG GMBL caution light on):

a. Place ENG GMBL switch to OFF

NOTE. —An extraneous keystroke will occur. It is desirable, therefore, to effect switch position when such keystroke will have no impact.

b. When a keystroke is required, place ENG GMBL switch momentarily in ENABLE; then return to OFF.

RECOVERY/
TERMINATION:

1. To terminate EMP 100A, key one of the following:

a. VERB 74 ENTR

VERB 37 ENTR xx ENTR

or

b. VERB 36 ENTR (Fresh Start)

or

c. VERB 21 NOUN 1 ENTR

335 ENTR

3532 ENTR

VERB 37 ENTR xx ENTR.

2. To recover from deactivation caused by a hardware restart, key (or uplink)—

VERB 31 ENTR.

ERASABLE
MEMORY: Padloaded coding for EMP 100A is as follows:

ECADR	Tag	Code		Octal
660	VAC5USE	OCT	0	00000
661		CA	ZERO	34746
662		TS	VAC5USE	54660
663		CA	BIT9	34734
664		EXTEND		00006
665		RAND	CHAN32	02032
666		XCH	MULTFLAG	56703
667		CCS	A	10000
670		TC	+2	00672
671		TC	CHKPHASE	00712
672		CCS	MULTFLAG	10703
673		TC	CHKPHASE	00712
674		CA	PRIO30	34346
675		TC	NOVAC	05063
676		2CADR	CHARIN	02057
677				60101
700		CA	KEYBKUP	30730
701		MASK	LOW5	74337
702		TC	AFTGOLOC	00710
703	MULTFLAG	OCT	400	00400
710	AFTGOLOC	INDEX	LOCCTR	50064
711		TS	MPAC	54154
712	CHKPHASE	CCS	PHASE1	10752
713		TC	DNPHASE2	03532
714		TC	PHASCHNG	05355
715		OCT	7011	07011
716		OCT	77777	77777
717		OCT	722	00722
720		OCT	10100	10100
721		TC	DNPHASE2	03532
722		CA	ZERO	34746
723		TS	VAC5USE	54660
724		CA	EPROGAD	30727
725		TS	DNTMGOTO	54335
726		TC	TASKOVER	05263
727	EPROGAD	OCT	661	00661
730	KEYBKUP	OCT	KK	000KK

UPLINK: Uplink for loading EMP 100A code by P27 is as follows:

Load 1	Load 2	Load 3	Load 4
V71E	V71E	V71E	V71E
20E	20E	17E	5E
660E	676E	714E	2371E
E	2057E	5355E	1E
34746E	60101E	7011E	722E
54660E	30730E	77777E	10100E
34734E	74337E	722E	V33E
6E	710E	10100E	
2032E	400E	3532E	
56703E	E	34746E	
10000E	E	54660E	
672E	E	30727E	
712E	E	54335E	
10703E	50064E	5263E	
712E	54154E	661E	
34346E	10752E	KKE	
5063E	3532E	V33E	
V33E	V33E		

NOTE. — Load 4 is the NOUN 26 load.

KK: 01 = "1"   20 = "0"

     02 = "2"   21 = "VERB"

     03 = "3"   22 = "RSET"

     04 = "4"   31 = "KEY REL"

     05 = "5"   32 = "+"

     06 = "6"   33 = "-"

     07 = "7"   34 = "ENTR"
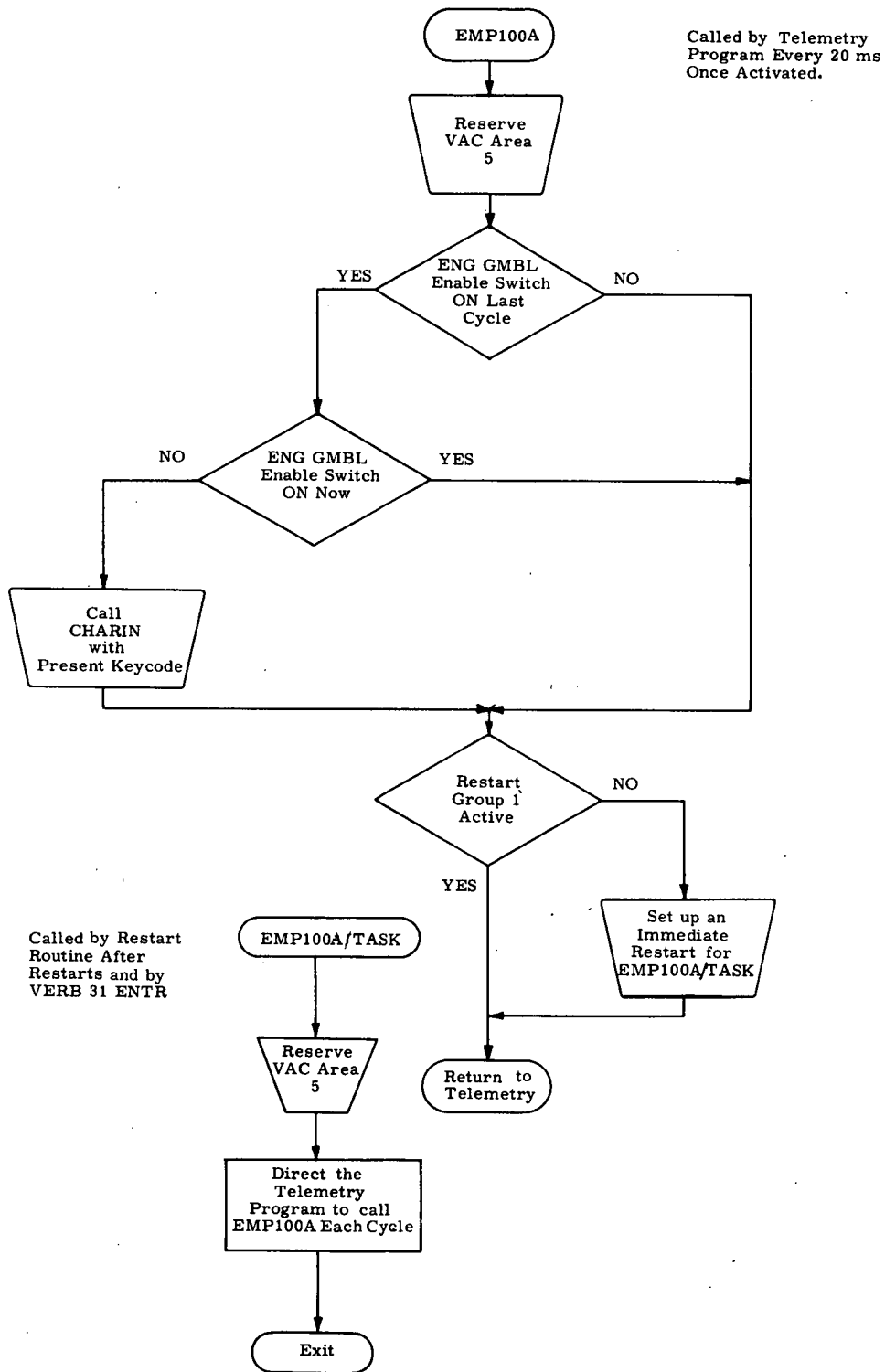
     10 = "8"   36 = "CLR"

     11 = "9"   37 = "NOUN"

EMP100A

Called by Telemetry
Program Every 20 ms
Once Activated.

Reserve
VAC Area
5

ENG GMBL
Enable Switch
ON Last
Cycle

YES   NO

ENG GMBL
Enable Switch
ON Now

NO   YES

Call
CHARIN
with
Present Keycode

Restart
Group 1
Active

NO

YES

Set up an
Immediate
Restart for
EMP100A/TASK

Called by Restart
Routine After
Restarts and by
VERB 31 ENTR

EMP100A/TASK

Reserve
VAC Area
5

Return to
Telemetry

Direct the
Telemetry
Program to call
EMP100A Each Cycle

Exit

Figure: EMP100A

100A-6

EMP 100B: BACKUP FOR FAILED DSKY KEY
USING MODE SEL SWITCH

PURPOSE:

Erasable Memory Program EMP 100B provides a means of using the MODE SEL switch to back up a failed DSKY key.

FUNCTIONAL
DESCRIPTION:

EMP 100B is activated by VERB 31 ENTR. Once activated, sampling occurs once every 20 ms to determine whether the MODE SEL switch has been moved from LDG RADAR or AGS to PGNS. (See Figure: EMP 100B.) If the MODE SEL switch is detected first at LDG RADAR or AGS and then at PGNS, a single executive call is made to the CHARIN routine of PINBALL. In this call, EMP 100B supplies the preset keycode identifier that corresponds to the DSKY button that has failed. The effect is as though the DSKY button itself were functional and had been depressed. In fact, there is a small time lag between the instant that the switch is placed in the PGNS position and the receipt of the keycode by the PINBALL program, but the lag is far too small to be sensed by the crew.

ASSUMPTIONS:

EMP 100B can be used for DSKY backup when—

1.   A DSKY key (other than PRO/STBY) has failed "open"; i.e., depressing key does not trigger an LGC KEYRUPT

2.   The program has been previously padloaded or uplinked

NOTE.—VAC Area 5 should be checked prior to activation of EMP 100B in order to ensure that the code has not been altered.

3.   High bit rate has been selected

RESTRICTIONS
AND LIMITATIONS:

1.   EMP 100B should not be activated while an erasable-memory dump (VERB 74) is in progress

2.   EMP 100B can be used to back up only one key at a time.

3.   There is an increase in probability of a 31201 BAILOUT restart during periods of high CPU activity. (VAC Area 5 is not available when EMP 100B is active.) This restart has no impact, however, on EMP 100B.

4.   There is a small increase (1.46 percent) in CPU time.

5.   EMP 100B is deactivated by

    a)   VERB 36 ENTR (Fresh Start)

    b)   VERB 74 ENTR (Erasable-memory dump)

6.   EMP 100B will be deactivated by a hardware restart occurring

    a)   during a small interval (<20 ms) following VERB 37 ENTR xx ENTR, entry to P70 and P71, or POODOOs;

    b)   during antenna repositioning in P64;

    c)   between TIG-30 and turn on of ullage during a powered-flight program.

PROCEDURES: When the prerequisite conditions exist (above), operate EMP 100B as follows:

A.   DSKY/UPLINK

1.   To change or load key code (KK),
key—
    VERB 21 NOUN 1 ENTR
    730 ENTR
    KK ENTR

2.   To activate,

    a)   key—
        VERB 5 NOUN 26 ENTR

    b)   observe—
        R1 00001
        R2 00722
        R3 10100

    c)   key—
        VERB 31 ENTR

B.   **MODE SEL SWITCH**

1.   If the MODE SEL switch is desired at PGNS—To effect keystroke, place the switch to LDG RADAR or AGS momentarily; then return switch to PGNS.

> NOTE.—Sample rate is 50 times per second; therefore, MODE SEL switch can be cycled as rapidly as necessary to effect data input.

2.   If MODE SEL switch is desired at LDG RADAR or AGS—When a keystroke is required, place the switch momentarily to PGNS; then return to LDG RADAR or AGS.

RECOVERY/
TERMINATION: 1.   To terminate EMP 100B either key—

a.   VERB 74 ENTR

VERB 37 ENTR xx ENTR

or

b.   VERB 36 ENTR (Fresh Start)

or

c.   VERB 21 NOUN 1 ENTR

335 ENTR

3532 ENTR

VERB 37 ENTR xx ENTR

2.   To recover from deactivation caused by a hardware restart, key (or uplink)—

VERB 31 ENTR

ERASABLE
MEMORY: Padloaded coding for EMP 100B is as follows:

ECADR	Tag	Code		Octal
660	VAC5USE	OCT	0	00000
661		CA	ZERO	34746
662		TS	VAC5USE	54660
663		CA	BIT6	34737
664		EXTEND		00006
665		RAND	CHAN30	02030
666		XCH	MULTFLAG	56703
667		CCS	A	10000
670		TC	+2	00672
671		TC	CHKPHASE	00712
672		CCS	MULTFLAG	10703
673		TC	CHKPHASE	00712
674		CA	PRIO30	34346
675		TC	NOVAC	05063
676		2CADR	CHARIN	02057
677				60101
700		CA	KEYBKUP	30730
701		MASK	LOW5	74337
702		TC	AFTGOLOC	00710
703	MULTFLAG	OCT	0	00000
710	AFTGOLOC	INDEX	LOCCTR	50064
711		TS	MPAC	54154
712	CHKPHASE	CCS	PHASE1	10752
713		TC	DNPHASE2	03532
714		TC	PHASCHNG	05355
715		OCT	7011	07011
716		OCT	77777	77777
717		OCT	722	00722
720		OCT	10100	10100
721		TC	DNPHASE2	03532
722		CA	ZERO	34746
723		TS	VAC5USE	54660
724		CA	EPROGAD	30727
725		TS	DNTMGOTO	54335
726		TC	TASKOVER	05263
727	EPROGAD	OCT	661	00661
730	KEYBKUP	OCT	KK	000KK

UPLINK: Uplink for loading EMP 100B code by P27 is as follows:

Load 1	Load 2	Load 3	Load 4
V71E	V71E	V71E	V71E
20E	20E	17E	5E
660E	676E	714E	2371E
E	2057E	5355E	1E
34746E	60101E	7011E	722E
54660E	30730E	77777E	10100E
34737E	74337E	722E	V33E
6E	710E	10100E	
2030E	E	3532E	
56703E	E	34746E	
10000E	E	54660E	
672E	E	30727E	
712E	E	54335E	
10703E	50064E	5263E	
712E	54154E	661E	
34346E	10752E	KKE	
5063E	3532E	V33E	
V33E	V33E		

NOTE.—Load 4 is the NOUN 26 load.

KK: 01 = "1"   20 = "0"

        02 = "2"   21 = "VERB"

        03 = "3"   22 = "RSET"

        04 = "4"   31 = "KEY REL"

        05 = "5"   32 = "+"

        06 = "6"   33 = "-"

        07 = "7"   34 = "ENTR"
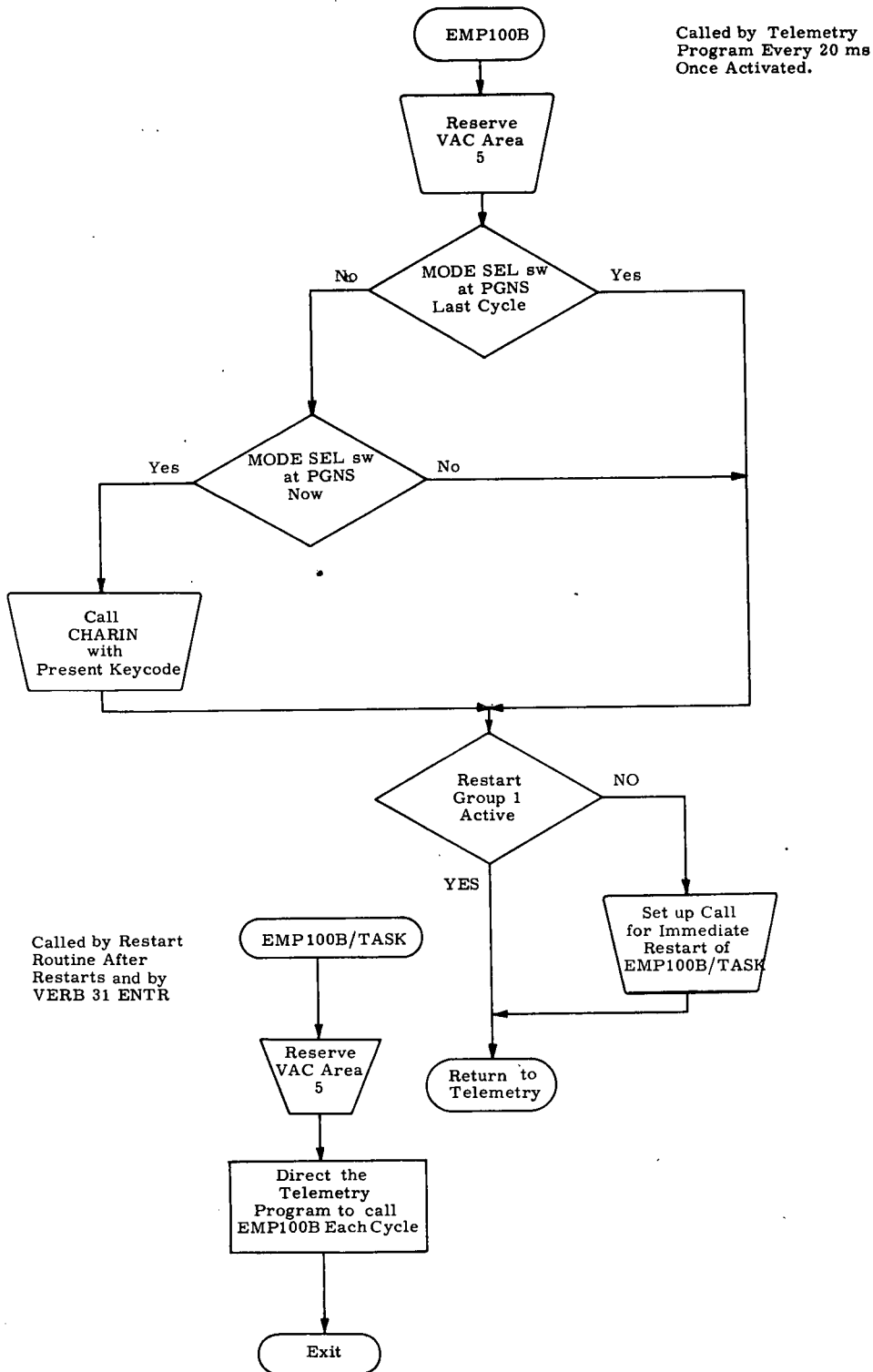
        10 = "8"   36 = "CLR"

        11 = "9"   37 = "NOUN"

Figure: EMP100B

EMP 101: P47 WITH DAP DRIVING GTS

PURPOSE:

EMP 101 provides a means of having the PGNCS control attitude by use of the GTS during a DPS P47 burn.

FUNCTIONAL
DESCRIPTION:

Two functions are provided by the PGNCS:

1. Display of NOUN 83, the velocity gained in body axes, which provides the criterion for burn termination;
2. Control of the vehicle attitude, including the use of GTS during the burn.

The NOUN 83 display is the normal output of P47. The display does not depend on the orientation of the IMU with respect to reference coordinates, but only with respect to body coordinates, provided by the CDUs.[*]

For the DAP to use the GTS when the engine is thrusting—and only when it is thrusting—the DPS/APS Thrust Fail Routine (R40) is manually set up. This is done by resetting IDLEFLAG (so that P47's SERVICER jobs will execute R40) and by loading the appropriate thrust threshold into DVTHRUSH. Further, the DAP is put in the powered-flight mode by resetting DRIFTBIT in DAPBOOLS. This causes the DAP to estimate angular accelerations and to honor VERB 65 commands inhibiting RCS pitch and roll control.

P47 integrates the LM state vector to current time. If the state vector time tag is very far from LGC clock time, this integration could take a long time. To avoid having to wait, the crew manually loads the state vector time (NOUN 38) with the clock time (NOUN 65). An erroneous state vector is of no concern unless it causes a POODOO 20430 or 21204 Alarm, which forces an exit from P47 (item 4 under RE-STRICTIONS AND LIMITATIONS).

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[*]The measured ΔV vector is transformed from IMU to reference coordinates by multiplication with REFSMMAT, but the vector is then transformed back by multiplication with the inverse of REFSMMAT. Consequently, the content of REFSMMAT makes no difference to the NOUN 83 display as long as the matrix is orthogonal.

ASSUMPTIONS: 1.   The IMU is on.

2.   REFSMMAT contains an orthogonal matrix.

3.   Current DAP data has been entered (R03).

4.   The GTS has been trimmed so that the thrust vector after initial compliance will pass within 1 degree of the c.g.

5.   The vehicle configuration can be LM-alone or LM docked to the CSM.

RESTRICTIONS
AND LIMITATIONS: 1.   DPS starting and stopping, ullage, and DPS throttling must be controlled manually.

2.   If the LGC senses a DPS thrust failure, the DAP will stop attempting to use the GTS as long as the failure lasts, but there will be no DSKY indication other than a decrease or cessation in the incrementing of NOUN 83.

3.   When SNUFFER is set (VERB 65) and DRIFTBIT is cleared, there will be no pitch and roll control with the RCS jets even if there is no DPS thrust. DRIFTBIT is automatically set by a major mode change, so this lock-out is terminated when P47 is exited. This inhibition does not affect manual attitude control that uses translational commands.

4.   The LM state vector must be such as not to cause a POODOO 20430 or 21204 Alarm at the beginning of P47. A 21204 Alarm results if the state-vector time is in the past and the computed time step is zero. A 20430 Alarm results if the integration-computed acceleration exceeds program limit. A subsurface state vector or erroneous erasable constant can cause these alarms.

5.   Attitude limit cycling will cause some fluctuating fraction of the total velocity gained to appear in the Y and Z components of NOUN 83 after the burn is terminated; for example, for a 0.5-deg DAP deadband, the fluctuation could be approximately 1 percent of the total Δv. Trimming these components will, therefore, be impossible to accomplish precisely by this display. (In the docked case, the long moment arm between the Y,Z translation jets and the center of gravity causes additional difficulty.)

PROCEDURES: 1.   Maneuver the vehicle to the burn attitude

2.   Coarse align IMU (optional):

Key—

        VERB 41 NOUN 20 ENTR

        ENTR

        ENTR

        ENTR

3.   Synchronize CDUs; exit coarse-align mode:

Key—

        VERB 40 NOUN 20 ENTR

4.   Set REFSMFLG:

Key—

        VERB 25 NOUN 7 ENTR

        77 ENTR

        10000 ENTR

        1 ENTR

5.   Set the threshold for the thrust monitor:

Key—

        VERB 21 NOUN 1 ENTR

        1250 ENTR

        14 ENTR (if docked to CSM)

        44 ENTR (if LM-alone)

6.   Enter P47; load the orbital integration time tag with the LGC clock time:

    a.   Key—

            VERB 37 ENTR 47 ENTR

    b.   Observe 47 in PROG registers

    c.   Key—

            VERB 6 NOUN 65 ENTR

    d.   Record three components:

            R1   +ooxxx. hr

            R2   +oooxx. min

            R3   +oxx.xx sec

    e.   Key—

            VERB 25 NOUN 38 ENTR

            (and load NOUN 65 values):

            +xxx ENTR

            +xx ENTR

            +xxxx ENTR

7. Enable thrust monitor (reset IDLEFLAG):
   Key—

       VERB 25 NOUN 7 ENTR

       103 ENTR

       100 ENTR

       ENTR

8. Put DAP in powered-flight status (reset DRIFTBIT):
   Key—

       VERB 25 NOUN 7 ENTR

       111 ENTR

       200 ENTR

       ENTR

9. Before ignition, ensure that the DAP is in the attitude-hold mode and, if docked with the CSM, that RCS pitch and roll control will not be exercised during the burn.

   > NOTE.—For jet inhibition, "the burn" begins when step 8 is performed. Step 9 can be performed earlier, depending upon how the attitude is held before the burn:

   a. MODE CONT (PGNS) set to ATT HOLD

   b. Key VERB 77 ENTR

   c. Key VERB 65 ENTR (only if docked to CSM)

10. Null the NOUN 83 display (accumulated Δv):
    Key—

        VERB 32 ENTR

11. Perform manual ullage as required

12. Perform manual engine start and manual throttle control

    > NOTE.—The initial CSM-docked throttle profile is 5-sec minimum thrust and 21 sec at 40 percent. The initial LM-alone profile is 26-sec minimum thrust.

13. Perform manual engine stop when NOUN 83 (R1) equals the desired Δv.

14. If docked, damp excessive pitch and roll rates via translation commands.

15. Exit P47: in the docked case, this re-allows automatic RCS pitch and roll control:

    Key—

        VERB 96 ENTR

16. Clear SNUFFER:

    Key—

        VERB 75 ENTR

RECOVERY/
TERMINATION: There is a very small chance that the load of NOUN 38 will not "take" because the internal computations overwrite the loaded values. If the COMP ACTY light on the DSKY stays on continuously for more than 8 seconds after NOUN 38 is loaded, the load should be repeated.

                 If the LM state vector is such as to cause POODOO Alarm 20430 or 21204 upon entry to P47, a new state vector must be loaded. P47 can then be called again.

ERASABLE
MEMORY: NA

UPLINK: NA

EMP 102: SOFTWARE RESTART

PURPOSE: EMP 102 provides a means of causing a software restart
                            by keying VERB 31 ENTR.

FUNCTIONAL
DESCRIPTION: EMP 102 uses existing fixed program code to perform
                            BAILOUT and store Alarm Code 31211.

ASSUMPTIONS: NA

RESTRICTIONS
AND LIMITATIONS: NA

PROCEDURES: 1.   Key VERB 25 NOUN 26 ENTR
                                                        1 ENTR
                                                     2040 ENTR
                                                    16000 ENTR
                            2.   To effect software restart,
                                     key VERB 31 ENTR
                            3.   Observe PROG alarm light
                            4.   Key VERB 5 NOUN 9 ENTR to observe alarm code
                                     31211, "Illegal interrupt of extended verb"
                            5.   Key RSET to clear alarm

RECOVERY/
TERMINATION: NA

ERASABLE
MEMORY: NA

UPLINK: NA

EMP 103A: DESCENT WITH FAILED CDUs

PURPOSE:
EMP 103A provides a means of computing actual CDU values and displaying commanded CDU values should one or more CDUs fail during lunar descent or abort. Although EMP 103A could be used to back up failed CDUs in P12, no testing of this has been done since P12 has both AGS and manual backup. M.I.T. is not able to fully simulate the control configuration needed to test this EMP. EMP 103A has been used, however, on the LMS at KSC and at the Grumman simulator.

FUNCTIONAL DESCRIPTION:
Every 2 seconds, EMP 103A computes the desired gimbal angles (CDUYD and CDUZD) from the thrust axis desired by guidance and computes values for the actual gimbal angles (CDUY and CDUZ) from the measured acceleration vector (DELV). CDUYD and CDUZD are put into NOUN 87 (displayed by VERB 16), which the crew flys using the AGS autopilot. A second part of EMP 103A, executed every 20 ms, zeroes CDUX and puts the computed actual gimbal angles into the CDUY and CDUZ registers for use by the radar update and other routines—but not by the PGNCS autopilot, which must be off.

ASSUMPTIONS:
1. IMU is stable and correctly aligned for landing
2. Attitude control performed by crew in AGS ATT HOLD
3. EMP 103A has been loaded. (See ERASABLE MEMORY and UPLINK.)
4. High bit rate has been selected.

RESTRICTIONS AND LIMITATIONS:
1. Unless CDUX is okay, landing-analog-display crosspointers give velocities in the downrange and crossrange directions rather than in the body-oriented forward and lateral directions.
2. The P64 landing-site redesignation capability should not be enabled (PRO response to FL VERB 06 NOUN 64 is unwise) since hand-controller deflections required in flying AGS attitude hold will be interpreted as site redesignations by the PGNCS.

3. Use of LR to update the PGNCS state vector is not advised when a bit failure has occurred that would allow CDU values to change in large increments.

4. EMP 103A consumes about 5 percent of the LGC duty cycle. Failure of a CDU in the runaway mode consumes about 7.5 percent per CDU. To conserve LGC time, therefore, it is necessary that the PGNCS DAP be turned off before the erasable program is activated. (See ASSUMPTIONS.)

5. Hardware restart vulnerability during antenna repositioning at High Gate: Simultaneous occurrence of hardware restart and crew selection of P70/P71 at High Gate might disable EMP 103A.

6. EMP 103A is deactivated by either

   a. VERB 74 ENTR

   or

   b. VERB 36 ENTR

7. EMP 103A should not be activated while an erasable-memory dump (VERB 74) is in progress.

8. There is some increase in the probability of a 31201/ 31202 BAILOUT restart during periods of high CPU activity. (VAC Area 5 and core sets 5, 6, and 7 are used to contain the EMP.)

9. Should a hardware or software restart (including VERB 37 ENTR xx ENTR) occur before EMP 103A activation, core sets 5, 6, and 7 and VAC area 5 should be checked to ensure that code has not been altered.

PROCEDURES: 1. Before PDI—

   a. GUID CONT to AGS
   b. MODE CONTROL PGNS to OFF
   c. Manual ullage
   d. Manual engine on

2. Between PDI and throttle up, if not sooner, key VERB 31 ENTR to activate erasable program.

NOTE.—Between PDI and throttle-up is the last possible moment for starting EMP 103A. If CDUZ is failed runaway, and EMP 103A is to be used for making the landing, it is better to use EMP 103A in the first place instead of EMP 108 for preventing GLOCKMON from falsely sensing gimbal lock (CDUZ greater than 85 deg) and throwing the IMU into coarse align. This is to avoid the difficulty of switching from one EMP to the other in midstream. Although the CDUs computed by EMP 103A would not be valid between TIG-30 and ullage, the single-precision arcsin routine used by EMP 103A cannot produce outputs greater than 81.4 deg. Therefore, CDUZ would never be computed as in gimbal lock.

3. After throttle up, key VERB 16 NOUN 87 ENTR to monitor desired CDUY and CDUZ values:

    R1   xxx.xx   deg CDUYD (pitch)
    R2   xxx.xx   deg CDUZD (roll)

    NOTE.—NOUN 87 values are invalid before Guidance begins at throttle up.

4. Referencing NOUN 87 and the FDAI Ball, maintain attitude with AGS autopilot.

    NOTE 1.—If yaw and roll are both nonzero on FDAI Ball, NOUN 87 (R1,R2) values for pitch and roll will not be equal to FDAI values. For the small roll angles (less than 3 deg) normal for landing, however, the NOUN 87 values are accurate enough to be used.

    NOTE 2.—NOUN 22 cannot be used because FINDCDUW may still be providing bad data.

    NOTE 3.—To determine when to enable LR state-vector updates, either depress KEY REL and observe NOUN 63 display of Delta H or ask ground to advise. (Yaw to zero before keying VERB 57 ENTR.)

RECOVERY/
TERMINATION: To deactivate EMP 103A and disengage restart protection,
                      key either:

        1.   VERB 74 ENTR
              VERB 37 ENTR xx ENTR
        2.   VERB 21 NOUN 1 ENTR
              335 ENTR
              3532 ENTR
              VERB 37 ENTR xx ENTR
        3.   VERB 36 ENTR

              NOTE.—EMP 103A can not be deactivated
              by methods 1 or 2 while SERVICER is
              running.

ERASABLE
MEMORY: EMP 103A coding is as follows:

> NOTE.—Should one or more CDUs be
> operating normally, it may be desirable
> to modify coding (*) to permit use of the
> good CDU data. If the only failure is
> CDUX, the FINDCDUW-computed values in
> NOUN 22 are accurate, but CDUX must
> still be overwritten to obtain valid radar
> data.

ECADR	Tag	Code		Octal
0250	TC	0300		00300
*0251	TS	CDUX		54032
0252	CCS	PHASE1		10752
0253	TC	0261		00261
0254	TC	PHASCHNG		05355
0255	OCT	07011		07011
0256	OCT	77777		77777
0257	OCT	00311		00311
0260	OCT	10100		10100
0261	NOOP			30000
0262	NOOP			30000
0263	MASK	7776		77776
0264	CS	AVGXIT		41251
0265	AD	0267		60267
0266	CCS	A		10000
0267	OCT	00661		00661
0270	OCT	00250		00250
0271	TC	0273		00273
0272	TC	0676		00676
0273	CA	AVGEXIT		31251
0274	TS	0674		54674
0275	CA	0267		30267
0276	TC	0675		00675
0277				77776
0300	CA	0270		30270
0301	TS	DNTMGOTO		54335
0302	CS	BIT1		44744
0303	TS	0263		54263
0304	TS	0277		54277
0305	TS	0313		54313
0306	CA	ZERO		34746
0307	TS	VAC5USE		54660
0310	TC	Q		00002
0311	TC	0300		00300
0312	TC	TASKOVER		05263
0313				77776
0660				00000
0661	TC	0300		00300
0662	TC	INTPRET		06060
0663	VLOAD	EXIT		77575
0664		UNFC/2		03252
0665	TC	0710		00710
0666	DXCH	AZ		53345

0667	TC	INTPRET	06060
0670	VLOAD	EXIT	77575
0671		DELV	00325
0672	TC	0710	00710
0673	DXCH	0702	52703
0674	TC	GUIDANCE	
0675	TS	AVGEXIT	55251
0676	EXTEND		00006
0677	DCA	0702	30703
*0700	DXCH	CDUY	52034
0701	TC	DNPHASE2	03532
0702			
0703			
0704			
0705			
0706			
0707			
0710	EXTEND		00006
0711	QXCH	0704	22704
0712	TC	INTPRET	06060
0713	UNIT	EXIT	77456
0714	CA	MPAC +3	30157
0715	TC	BANKCALL	04607
0716	CADR	SPARCSIN -1	61656
0717	TS	0705	54705
0720	TC	INTPRET	06060
0721	RTB	UNIT	53434
0722		ZEROMID	63671
0723	EXIT		77776
0724	LXCH	MPAC	22154
0725	CS	MPAC +5	40161
0726	TC	BANKCALL	04607
0727	CADR	ARCTRGSP	61606
0730	LXCH	0705	22705
0731	TC	0704	00704

*For individual CDU failure, load indicated location according to table.

	CDU		
LOC	X FAIL	Y FAIL	Z FAIL
251	54032	30000	30000
700	30000	54033	22034

UPLINK
(or DSKY):   P27 uplink (or DSKY entry in P00):

Load 1	Load 2	Load 3	Load 4	Load 5
V71E	V71E	V71E	V71E	V72E
24E	24E	24E	24E	15E
250E	272E	660E	710E	1251E
300E	676E	E	6E	3656E
*54032E	31251E	300E	22704E	702E
10752E	54674E	6060E	6060E	E
261E	30267E	77575E	77456E	703E
5355E	675E	3252E	30157E	E
7011E	77776E	710E	4607E	2371E
77777E	30270E	53345E	61656E	1E
311E	54335E	6060E	54705E	2372E
10100E	44744E	77575E	6060E	311E
30000E	54263E	325E	53434E	2373E
30000E	54277E	710E	63671E	E
77776E	54313E	52703E	77776E	V33E
41251E	34746E	E	22154E	
60267E	54660E	55251E	40161E	
10000E	2E	6E	4607E	
661E	300E	30703E	61606E	
250E	5263E	*52034E	22705E	
273E	77776E	3532E	704E	
V33E	V33E	V33E	V33E	

*See table under ERASABLE MEMORY.

EMP 106: INCREMENT AOT DETENT POSITION

PURPOSE: EMP 106 provides the Lunar Surface Sighting Mark Routine (R59) with a means of computing the cursor and spiral angles displayed by NOUN 79 for an advanced AOT detent position.

FUNCTIONAL
DESCRIPTION: EMP 106 redirects the PRO response to NOUN 79 to the location in R59 that increments the detent position code and recomputes the cursor and spiral angles.

ASSUMPTIONS: 1. IMU is on and REFSMMAT is valid.
2. The star selected under NOUN 70 is present in the AOT field of view for two detent positions.

RESTRICTIONS
AND LIMITATIONS: 1. EMP 106 procedures must be keyed into the DSKY by the operator during the NOUN 79 display in R59.
2. EMP 106 is self-destructing and must be re-established with each usage.
3. When EMP 106 is active—
    a. A VERB 34 ENTR response to FL VERB 06 NOUN 79 causes the detent to advance the same as for a PRO response (does not terminate).
    b. A VERB 32 ENTR recycles the FL VERB 06 NOUN 79 display (does not recycle to FL VERB 01 NOUN 70 to redefine a star).
    c. An ENTR response causes the KEY REL light to come on and recycles the FL VERB 06 NOUN 79 display.
    NOTE.—Both response a and response b destroy EMP 106. Response c does not.

PROCEDURE: 1. During the FL VERB 06 NOUN 79 display of R59, key

VERB 21 NOUN 1 ENTR
373 ENTR
32533 ENTR

2. To advance detent and destroy EMP 106, key PRO

RECOVERY/
TERMINATION: See RESTRICTIONS AND LIMITATIONS, Item 2.

ERASABLE
MEMORY: NA

UPLINK: NA

EMP 108: ZERO A RUNAWAY IMU CDU AND PREVENT COARSE ALIGN

PURPOSE: EMP 108 provides a means of preventing T4RUPT from causing IMU to switch to coarse-align mode when CDUZ exceeds ±85 deg as a result of runaway CDUZ. Alternatively, EMP 108 can be used to zero CDUX or CDUY. See table under ERASABLE MEMORY.

FUNCTIONAL
DESCRIPTION: EMP 108 causes zero to be loaded into the failed CDU every 20 ms as part of the DOWNRUPT processing interrupt.

ASSUMPTIONS:
1. Valid data from failed CDU are not required during time EMP 108 will be activated.
2. High bit rate has been selected.

RESTRICTIONS
AND LIMITATIONS:
1. EMP 108 should not be activated while an erasable-memory dump (VERB 74) is in progress.
2. There is some increase in the probability of a 31201 BAILOUT restart during periods of high CPU activity. (VAC Area 5 is not available when EMP 108 is active.) This restart has no impact, however, on EMP 108.
3. There is a small increase (0.5 percent) in CPU time.
4. Should a hardware or software restart (including VERB 37) occur before EMP 108 activation, VAC Area 5 should be checked to ensure that code has not been altered.
5. IMU/CDU operations may not be successful.
6. EMP 108 has not been verified for operation with the DAP active; the DAP should be placed in the idling or minimum impulse mode.
7. EMP 108 is deactivated by
   a) VERB 36 ENTR (Fresh Start);
   b) VERB 74 ENTR (erasable-memory dump).
8. EMP 108 is deactivated by a hardware restart occurring
   a) during a small interval (<20 ms) following VERB 37 ENTR xx ENTR, entry to P70 and P71, or after POODOOs;
   b) during antenna repositioning in P64;

c) between TIG-30 and turn on of ullage during a powered-flight program.

9. EMP 108 when used with the CDUZ deactivates the automatic moding to coarse align at gimbal angles greater than ±85 deg; maneuvering the vehicle into the area of a real gimbal lock will cause loss of inertial reference, with possible permanent damage to the IMU.

PROCEDURES:

1. Key VERB 5 NOUN 26 ENTR and verify contents:
    R1 = 00001
    R2 = 00674
    R3 = 10100

2. To activate EMP 108, key —
    VERB 31 ENTR.

RECOVERY/
TERMINATION:

1. To deactivate EMP 108, key one of the following:

    a. VERB 74 ENTR
        VERB 37 ENTR xx ENTR
        VERB 40 NOUN 20 ENTR
    or

    b. VERB 36 ENTR
    or

    c. VERB 21 NOUN 1 ENTR
        335 ENTR
        3532 ENTR
        VERB 37 ENTR xx ENTR
        VERB 40 NOUN 20 ENTR

2. To recover from deactivation caused by a hardware restart, key—
    VERB 31 ENTR

ERASABLE
MEMORY: Program coding for EMP 108 is as follows:

ECADR	Tag	Code		Octal
660	VAC5USE	OCT	0	00000
661		CA	ZERO	34746
662		TS	VAC5USE	54660
*663		TS	CDUZ	54034
664		CCS	PHASE1	10752
665		TC	DNPHASE2	03532
666		TC	PHASCHNG	05355
667		OCT	07011	07011
670		OCT	77777	77777
671		ADRES	EPROGNIT	00674
672		OCT	10100	10100
673		TC	DNPHASE2	03532
674	EPROGNIT	CA	ZERO	34746
675		TS	VAC5USE	54660
676		CA	EPROGAD	30701
677		TS	DNTMGOTO	54335
700		TC	TASKOVER	05263
701	EPROGAD	ADRES	VAC5USE+1	00661

*For individual CDU failure, load according to the following:

ECADR	CDUX	CDUY	CDUZ
663	54032	54033	54034

UPLINK: Uplink for loading EMP 108 code by P27 is as follows:

Load 1	Load 2
V71E	V71E
24E	5E
660E	2371E
E	1E
34746E	674E
54660E	10100E
54034E*	V33E
10752E	
3532E	
5355E	
7011E	
77777E	
674E	
10100E	
3532E	
34746E	
54660E	
30701E	
54335E	
5263E	
661E	
V33E	

*CDUZ failure. For CDUX failure, load 54032; for CDUY failure, load 54033.

F

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Brand   Levine
Gustafson   Muller
Higgins   Pu
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